in the winter season because they have been long adjusted to the particular climatic conditions of eastern North America. Meteorologists tell us that this exceptional weather has had a counterpart in the past, and as our native plants have existed for many thousands of years, there is no doubt but that they have many times been exposed to conditions to be found to-day.

Then there are many plants which normally blossom early in the year before actual spring conditions come. In this category are the skunk cabbage, the witch hazel, and the like. These plants are not especially injured by periods of cold weather succeeding an open winter.

In addition, there are a few plants introduced from Europe and other countries, such as the Japanese witch hazel, the snowdrop, the winter aconite, and the Christmas hellebore and others, which frequently flower in January succeeding a few days of open, warm weather. When this warm spell is in turn followed by snow, the winter aconite and the rest of these garden species are completely covered up, and when that snow melts they are found to be uninjured.

Snow is good protection to plants.—In fact, snow is one of the best protections that plant life has against the rigors of winter. A cold, snowless winter, with high winds and low temperature, is much more destructive, generally speaking, to plant life than a winter with a heavy snowfall. This ability of the snow to act as a blanket for plants has been repeatedly shown in the north of Italy, where an early spring snowfall will do less damage to crops than a late, snowless period of cold weather accompanied by high winds and bright sunlight.

During the early months of 1920 there was a very interesting exemplification of the action of a frozen soil and cold weather. The soil was frozen to the depth of more than a foot and later a heavy snowfall came, which partly melted and was again frozen to form an icy sheet several inches thick. This was followed by an extremely cold spell with strong winds and bright sunlight, which, however, was counteracted by the blanket of snow and ice.

It is a fact, however, that hardly any season in the annals of Philadelphia horticulture has been more trying and detrimental to conifers, rhododendrons, and other evergreens than was last season. Rhododendrons were destroyed by thousands where gardeners had not had the forethought to cover the roots with a heavy mulch of forest leaves and other litter. The reason for this destructive action was the fact that during the winter rhododendrons and kindred species are constantly giving off considerable amounts of moisture, and this loss of water from the surface of the plant is increased by bright sunlight and strong winds. The water thus given off during an ordinary winter is obtained from the soil, but in 1920 the soil was frozen to such a depth that the roots were unable to obtain the water necessary to replenish the loss from the surface, and consequently the plants dried up, their leaves turning brown and withering, with a result as disastrous to the tops of the plants as a fire would have been.

Many plants get rest in winter.—The period of winter is advantageous to many plants, which enter a period of rest at this time, giving an opportunity for the ripening of the wood and the maturing of the buds. This has a beneficial result on the gradual preparation of the underground parts of the plants for the burst of spring growth. In fact, some bulbs and some seeds will not begin growth until they have been subjected to either the cold of winter or the drought of such climates as we find in the great deserts.

This feature is known as the "rest period," and for this reason an open winter, in giving no such opportunity, is sometimes succeeded by a less vigorous growth the following spring, as contrasted with a winter of abundant snowfalls and normally low temperatures, which produce the necessary ripening effect on buds and other dormant parts of the plant.

A cold spell is particularly dangerous to plant life after a period of warm rains with open grounds, because most plants absorb water during the winter and become gorged in their overground parts. A subsequent freezing is liable to burst the delicate tissues of the plants. Frost cracks on trees are a good example of this danger, and they are quite likely to result, particularly if the cold spell is followed by bright sunlight. Without the latter the water which is frozen out of the plant tissues may be absorbed back again so slowly into the living cells of that plant that the destructive action is prevented; but with bright sunlight the ice is expanded within the plant, resulting in the aforementioned rupture of plant tissues.

For this reason, in the protection of delicate plants it is more important frequently to protect them from the sunlight in winter than from the cold weather.

Plants safe if buds are closed.—The danger of frost in the spring or in any open spell of weather during the winter months is largely due to the influence which heat has in expanding buds and starting dormant parts of plant life into activity. As long as buds remain closed there is ordinarily little cause for worry from succeeding cold weather, but if the warm period is of long enough duration to cause the buds to expand the following cold weather generally destroys the delicate parts within, which are then no longer protected by the bud scales. The latter are provided by nature with cork, resin, or cottony or silky hairs to offer resistance to the action of the climate.

The most destructive action in buds is the entrance of water between the bud scales, for this expands in freezing and tears the frail parts of the plants to pieces. The presence of the resin and other of nature's aids helps prevent this state of affairs.

On the other hand, it is equally true that the presence of frost and ice is very beneficial to the soil in which many plants are found, because it tends to pulverize the larger soil particles through the expansion of the ice particles. As a consequence, soil exposed to the action of frost is mellowed and made fit for the growth of subsequent crops.

A final destructive effect of an open winter as contrasted with a normal one is the fact that many plants are stimulated unduly, thus shortening their lives, because the reserve foods are used up before the rapid demand of the plant comes for the expenditure of such stored materials.

FREEZING OF FRUIT BUDS.

By FRANK L. WEST and N. E. EDLEFSEN.

[Extracted from Journal of Agricultural Research, Jan. 15, 1921, Vol. XX, No. 8, pp. 655-662.]

[Authors' summary.]

(1) Efficient orchard heating demands an economical use of labor and fuel and requires knowledge of the temperatures that cause injury to the buds.

(2) This paper contains the results of seven years' experiments in freezing 24,000 apple, peach, cherry, and apricot buds, together with a record of the natural freezes

that occurred in the orchards near Logan, Utah, during the same period.

(3) Ben Davis apple buds in full bloom have experienced temperatures of 25°, 26°, and 27° F., without injury, but 28° usually kills about one-fifth. Twenty-nine degrees or above are safe temperatures. Twenty-five degrees kills about one-half and 22° about nine-tenths. On several occasions, however, apples matured on branches that experienced 20° when the buds were in full bloom.

(4) With Elberta peach buds in full bloom, 29° F., or above, are the safe temperatures, because even though occasionally 26°, 27°, and 28° do no damage, yet on most occasions 28° will kill from one-fourth to one-half. Twenty-six degrees kills about one-half of them and 22° about nine-tenths. Temperatures as low as 18° have failed to kill all of them.

(5) With sweet cherry buds in full bloom, 30° F. is the safe temperature; 25°, 26°, 27°, 28° have done no damage; but 29° usually kills about one-fifth. Twenty-five degrees usually kills about one-half, and when the buds were showing color 22° killed only two-fifths of the buds.

(6) Sour cherries are hardier than the sweet varieties. When the buds were showing color 23° did not harm them, and when they were in full bloom 26° killed but one-fifth and 22° only two-fifths of them.

(7) With apricots 29° is the safe temperature; 26° and 27° killed about one-fifth and 22° killed one-half. They are fairly hardy, but they bloom so early that they are frozen oftener than any of the other fruits studied in the experiments.

(8) The foregoing figures refer to the buds when in full bloom. Starting from this stage, the earlier the stage of development the hardier the buds are; and in general, when the fruit is setting the injury is from 5 to 10 per cent more than when they are in full bloom.

(9) Sour cherries are the hardiest, and then follow in order apples, peaches, apricots, and sweet cherries.

(10) The fact that the same branch of buds will on one occasion experience 27° with 25 per cent injury and on another occasion take the same temperature with no injury is no doubt due to the fact that the juice is contained in capillary cells and supercooling results—that is, the buds are cooled below the freezing point of the juice without the freezing taking place. The great difficulty of killing all the buds even at extremely low temperatures is due to the same cause, together with the fact that the cell sap may be very concentrated. Differences in the hardiness of the different kinds of buds and also of the same buds at different stages of development is due to differences in quality and concentration of the cell sap.

551.578.7 (782)

SEVERE HAILSTORM IN NEBRASKA.

HARRY G. CARTER, Meteorologist.

[Weather Bureau, Lincoln, Nebr., Dec. 22, 1920.]

On Friday, July 16, 1920, there occurred in Antelope and Boone Counties, in northeastern Nebraska, an unusually severe hailstorm.

The center of the path of greatest destruction extended from south of Royal and Brunswick, in Antelope County, to a point just east of Neligh, thence southward directly through Oakdale, east of Elgin, Petersburg, Loretto, Albion, and Boone, through St. Edward and between Fullerton and Genoa to the Platte River, a distance of nearly 70 miles. The area over which hail fell varied from 1 mile to 6 miles in width. No reports were received of hail from stations south of the Platte River.

In the area of greatest destruction portions of farms were swept nearly clear of vegetation. Small grain was pounded flat to the ground and some fields were left nearly bare, and in places it was difficult to tell just what crop had occupied the field before the storm struck. Here and there nothing remained of corn but battered stalks from a few inches to a few feet in height. Trees were divested of foliage and bark stripped off on the side facing the storm. The high wind uprooted trees and wrecked farm buildings, while the hail broke nearly all the windows on the north side of farm houses and buildings and many on the east side, besides damaging many roofs so badly that the rain poured through and damaged the interior. An excessive downpour caused a few streams to overflow their banks so that in places the devastated region suffered loss from floods in addition to loss from hail and wind.

Some farmers in the stricken region lost a large portion of their growing crops. A few sowed millet, cane, or buckwheat in their storm-swept fields. A number found it necessary to dispose of their surplus hogs and cattle as it was impossible to provide feed for them.

The greatest damage occurred in the region adjacent to Oakdale, in Antelope County. North of Oakdale but a relatively small area suffered loss, while to the southward from Oakdale to a point nearly east of Albion, in Boone County, there was considerable damage to various crops. East of Albion the hailstones were smaller, the wind velocity less, the rain fell at a slower rate, and the damage to crops was consequently less than to the northward. From here southward the storm gradually decreased in intensity, and south of the Platte River no hail was reported.

The hail was an accompaniment of a thunderstorm of unusual severity. The wind at places approached hurricane strength, but at no time was there any indication of tornadic action, the damage by the wind in every case reported being the result of a straight blow. All reports state that the greatest damage to buildings by hail was on the north side, although at some places the east side suffered nearly equal damage.

The hailstones varied in size from ½ inch to more than 2½ inches in diameter, and were mostly round. Some observers, however, reported hailstones that were "flattened spheres" and "irregular chunks of ice." The surfaces of the hailstones were mostly smooth, although some were rough. No marked protuberances were noticed.

The hail began to fall soon after the beginning of the rain, the interval varying from a few minutes to more than 30 minutes, the average time being somewhat less than 15 minutes. Rain fell from 30 minutes to 2½ hours, the time being less and the rate of fall greater in the northern portion of the area. Hail fell from 15 minutes to an hour, at most places the time being less than 30 minutes. It continued longer in the southern end of the belt than in the northern.

Neligh was on the western edge of the storm. Here rain fell from 2:50 p. m. to 3:20 p. m., and although hail fell for 20 minutes (from 3 p. m. to 3:20 p. m.) the hailstones were not unusually large and caused no material